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TECHNICAL REPORT
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TECHNICAL OBJECTIVE DOCUMENT FOR COMBAT CLOTHING, UNIFORMS, AND INTEGRATED PROTECTIVE SYSTEMS

BY

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FOR THE PERIOD 1 OCTOBER 1986 TO 4 MAY 1988

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This document provides information on the Army's technical objectives for the Combat Clothing, Uniforms, and Integrated Protective Systems areas to the external community, both Government and nongovernment, including academic, scientific, and industrial organizations. Its purpose is to stimulate the participation of such organizations in Army research and development. Areas include:

Management Review,
Technology Base Investment Strategy,
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TABLE OF CONTENTS

TECHNICAL OBJECTIVE DOCUMENT FOR COMBAT CLOTHING, UNIFORMS, AND INTEGRATED PROTECTIVE SYSTEMS

I. INTRODUCTION

The U.S. Army Technical Objective Document is an important part of the Army's Information for Industry Program. Each Army laboratory and research, development and engineering center has an opportunity annually to prepare a Technical Objective Document based upon Army requirements, scientific and technological opportunities, and the needs of present and projected systems.

We all recognize that the developments and accomplishments of the Army are the product of teamwork among Army scientists and engineers and their counterparts in industry and the academic community. This document is intended to increase this teamwork by providing you -- industry and academia -- with necessary information on our research, development and acquisition program. Specific objectives are:

To provide planning information for independent research and development programs.

To improve the quality of unsolicited proposals and R&D procurements.

To encourage face-to-face discussions between Army engineers and scientists and their nonmilitary counterparts in the private sector and their industrial and academic counterparts.

As you read through the pages that follow, you may see an opportunity to which your organization can respond. We invite you to discuss the opportunity with the scientist or engineer identified therein. Furthermore, you may have completely new ideas not considered in this document which, if brought to the attention of the proper organization, could make a significant contribution to the Army's capabilities. The Army has a continuing interest in receiving proposals that contain new ideas, suggestions, and innovative concepts for weapons, supplies, facilities, devices and equipment. In other words, your ideas, whether in response to this document or not, are always welcome.

Unclassified/unlimited distribution documents are available from the National Technical Information Service, while classified/limited distribution Technical Objective Documents are available from the Defense Technical Information Center. These documents, as well as additional information on doing business with the Army, are also available from the Army's Technical and Industrial Liaison Offices.

II. MANAGEMENT OVERVIEW

1. MISSION

The mission of the U.S. Army Natick Research, Development and Engineering Center (Natick) is to ensure maximum survivability, supportability, sustainability and combat effectiveness of individual soldiers and crews on the battlefield under worldwide environmental extremes.

Our goal is to provide the American soldier the best equipment for the best price through research, development, and engineering in the areas of Airdrop Systems, Food and Food Service Systems, Tactical Shelters, and Clothing and Individual Equipment. We are deeply committed to making our soldiers, and all Service members, the best equipped and best fed in the world.

2. ORGANIZATIONAL STRUCTURE

Natick is an element of the U. S. Army Troop Support Command, a major subordinate command of the U.S. Army Materiel Command (AMC). We are currently organized with three commodity-oriented Directorates: the Individual Protection Directorate (IPD), the Food Engineering Directorate (FED), and the Aero-Mechanical Engineering Directorate (AMED); three technical support directorates -- the Advanced Systems Concepts Directorate (ASCD), the Science and Advanced Technology Directorate (SATD), and the Engineering Programs Management Directorate (EPMD); and requisite administrative support elements.

Our commodity Directorates are responsible for planning, organizing and conducting/overseeing the conduct of all required research, development and engineering in their assigned areas. IPD performs these functions for CLOTHING AND INDIVIDUAL EQUIPMENT (CIE) and also coordinates all Army contributing RD&E efforts concerned with the protection of the individual soldier.

3. PROGRAM AREAS

Natick's programs encompass the total spectrum of research, exploratory, advanced and full-scale engineering development and the operations and maintenance activities essential for standardization and production engineering in support of procurement. Our efforts are focused primarily on three commodity areas and include several distinct fields of endeavor, all covered by the U.S. Army Materiel Command (AMC)/U.S. Army Training and Doctrine Command's (TRADOC) Combat Service Support Mission Area Materiel Plan (CSS MAMP). They are:

AIRDROP AND COMBAT SERVICE SUPPORT

- Advanced Personnel and Cargo Airdrop Systems
- Hardened Shelter Systems
- Tentage and Organizational Equipment Systems

COMBAT CLOTHING AND INDIVIDUAL EQUIPMENT	- Lightening the Soldier's Load - Ballistic Protection - NBC Protection - Countersurveilance/Flame/ DEW Protection - Environmental Protective Clothing - Microclimate Conditioning Equipment
FOOD ENGINEERING AND FOOD SERVICE EQUIPMENT	- Combat Feeding Systems - Operational Rations - Ration Packaging Systems

Our overall program is planned and prioritized in response to the deficiencies in the TRADOC Battlefield Development Plan and is fully coordinated with the user. Its execution is effectively managed using a modern management control system to ensure that the individual soldier's needs are accurately identified and expeditiously addressed.

4. PROGRAM GOALS

Our program goals are to:

- o Ensure maximum survivability, supportability, sustainability and combat effectiveness of individual soldiers and crews at all times under all environmental conditions.
- o Be the Center of Excellence for research, development and engineering in combat rations and food service systems, combat clothing and individual protective equipment, tactical shelters and tentage, airdrop systems and organizational equipment.
- o Achieve major technological and system improvements on highest priority user-relevant programs and expedite fielding of these improvements.
- o Exploit the worldwide technology base to achieve mission technology superiority.
- o Plan and conduct technology base programs that support development of Natick's Next Generation/Notional Systems (NG/NS) by addressing major technology barriers.
- o Optimize the use of resources to enhance productivity.
- o Maintain a cohesive long-range R&D plan and a corporate strategy to achieve and sustain mission superiority.

III. TECHNOLOGY BASE INVESTMENT STRATEGY

Technology is the lifeblood of new and improved Army systems and equipment. However, technology can only be an effective force multiplier if the application is fielded quickly. Streamlined acquisition measures are used by Natick to shorten the time between proving a concept feasible and putting a system in the hands of troops.

Exploiting new technologies to field affordable systems and equipment for the Army is a challenging process, one that is becoming institutionalized at both AMC and TRADOC through comprehensive analysis and long-range planning. The Army's Long-Range Research, Development, and Acquisition Plan (LRRDAP), TRADOC Mission Area Development Plan (MADP), and AMC/TRADOC Mission Area Materiel Plan (MAMP) provide the means for articulating a strategy for overcoming battlefield deficiencies and a rational allocation of resources based on criticality of need. The link between mission area strategies and technology base planning is a set of Next Generation and Notional Systems (NG/NS).

Natick is the proponent for several NG/NS, including one for the CIE area entitled "Integrated Protective Clothing System", which is described in the Appendix. NG/NS are generally described in conceptual terms and provide a set of references and targets for technology base efforts needed by focusing on specific critical technological barriers.

Natick's technology base investment strategy is composed of four major elements:

1. NEXT GENERATION AND NOTIONAL SYSTEMS

Approximately 50 percent of our technology base resources (6.1 basic research, 6.2 exploratory development, and 6.3A proof-of-principle demo) is allocated in support of specific Next Generation and Notional Systems (NG/NS). These are the systems that will begin full-scale development in the 1990s and will provide a fielded capability into the 21st century. For each system, the technological barriers have been identified, barriers that could prevent achievement of the capabilities desired. Programs and proof-of-principle demonstrations of prototypes (tech demos) have been structured in a logical, time-phased manner.

2. EMERGING TECHNOLOGIES

The potential of some emerging technologies is so great that it warrants special visibility and management attention even when its application to a specific system is unclear. About 20 percent of our technology base's total resources is dedicated to nurturing such high-payoff technologies. In the CIE area, our key emerging technologies fall into the biotechnology and advanced materials and processes areas.

3. CHRONIC PROBLEMS

Chronic problems that face the Army, such as lightening the soldier's load, sizing and tariff of CIE, lend themselves to technological solutions, but

often do not have a system focus. About 25 percent of our technology base resources is allocated for these kinds of problems to make sure that they get the attention they require.

4. SUPPORTING CAPABILITIES

Finally, our investment strategy allocates about five percent of Natick's resources in support of analytical capabilities. These include front-end analyses, modeling and simulations, ADP data base development, special-purpose equipment, and other infrastructure items that ensure our continuing ability to execute quality R&D programs and act as smart buyers across the entire spectrum of the materiel life cycle.

IV. CLOTHING AND INDIVIDUAL EQUIPMENT

1. OVERVIEW

Natick's CIE technology program is directed toward advanced Integrated Combat Clothing Systems. There are five basic climatic environments for which the Army provides clothing systems: They are: hot/wet, hot/dry, temperate, cold/wet, and cold/dry. In some areas, seasonal variations in climate necessitate the issue of more than one clothing ensemble. In addition, protection from special hazards requires separate issue of unique items, such as a chemical-protective overgarment or a ballistic-protective vest. Applied research efforts in the CIE area have been conducted in a group of separate technology areas supporting CIE development. Emphasis has been and continues to be placed on improving individual soldier survivability, reducing the soldier's load, and lessening the logistic burden in the CIE area. Applied research efforts in each area are aimed at integrating the technology advances in these areas into a single item or system of clothing or equipment, instead of a large number of separate items. The development of CIE, providing integrated protection in a single item or system at a level meeting Army requirements, is the technological challenge for the next decade. The CIE technology areas include:

a. Ballistic Protection

b. Directed Energy Protection

c. Chemical/Biological Protection

d. Microclimate Conditioning

e. Flame Protection

f. Passive Countersurveillance (camouflage)

g. Environmental Protective Clothing and Equipment

h. Material Degradation

i. Clothing and Equipment Design and Sizing

2. TECHNICAL OBJECTIVES

Our technical objectives in the CIE area include:

a. Near Term (current to five years):

(1) Enhancement of personal armor, chemical/biological protective clothing, countersurveillance protection, and total life support systems to meet next generation threats.

(2) Achievement of further weight reduction in combat clothing and equipment, and provision of effective leadership for the DA/AMC Lightening the Soldier's Load Tech Demo.

(3) Development of ballistic and laser protective eyewear.

(4) Provision of timely and effective support to:

Special Operations Forces (SOF)
Light Infantry Divisions (LID)
Low-Intensity Conflict (LIC)
Army Test Beds (ATB) and other specialized program requirements.

(5) Establishment, maintenance, and implementation of a state-of-the-art data base on the anthropometry of today's and tomorrow's soldier.

(6) Improvement in the appearance of Army Uniforms.

b. Mid-Term (5 to 10 years):

Initial development and successful demonstration of the major components of the NG/NS for the Integrated Protective Clothing System are detailed in the Appendix.

c. Long-Term (10 to 20 years):

Completion of advanced development and successful transition of the NG/NS for the Integrated Protective Clothing System to full-scale engineering development.

3. PROGRESS AND ACCOMPLISHMENTS

Natick is responsible for many significant RDTE programs. Military relevance, quality products, mission productivity, progressive management initiatives, and technical competence are synonymous with our programs, our staff, and our achievements. Through engineering for today, development for tomorrow, and research for the future, we are truly providing the decisive edge for the American soldier. We have, for example, focused our tech base programs toward the technologies needed for NG/NS, while still

addressing the chronic Army problems, emerging technologies and required supporting capabilities. Examples of our FY87 accomplishments in the CIE area follow.

a. Research Program (6.1): During FY87, our research program included the following accomplishments:

Identified strains of mutated microorganisms with highest production of chemical agent-degrading enzymes.

Developed a mathematical model to predict liquid spreading and penetration in model fabric systems for prediction of performance against live agents.

Determined water requirements of immobilized metal ion complexes to enhance activity against chemical agents.

Synthesized and evaluated transparent copolymers for ballistic eye protection characteristics.

Developed and evaluated fabrics for microwave protection.

b. Technology Program (6.2): During FY87, our Technology Program accomplishments included:

CAMOUFLAGE PATTERN PRINTED ARAMIDS: A technological breakthrough was achieved in the area of camouflage protection. Effective methods have been developed for the first time for camouflage printing of the aramids (Nomex and Kevlar), overcoming their problem (high glass transition temperature), and allowing hitherto undyeable material to be dyed and overprinted in a Woodland pattern.

HIGH-PERFORMANCE INSULATION: Identified materials that offer significantly improved insulation properties as compared to conventional fiber-fill materials. These materials possess the insulating capability of down, while mitigating some of its adverse properties, such as the long drying times and the loss of wet loft that is typical of down.

LIGHTWEIGHT BALLISTIC PROTECTION: Demonstrated the potential of new fibers composed of highly oriented polyethylene and polybenzthiazole to provide ballistic protection equivalent to current aramid fibers, but at reduced weights.

FLAME-RESISTANT BUTYL RUBBER: An effective process has been developed to provide flame resistance to butyl rubber without degradation of the required protection against mustard gas and nerve agents. This accomplishment can be extended to developmental work on chemically protective gloves, boots and coated fabrics.

DESERT CAMOUFLAGE: A significant improvement was made in the area of camouflage protection for the individual soldier operating in a

desert environment. Using the results of extensive photometric research on domestic and foreign sands, Natick redesigned the camouflage pattern for desert uniforms from a six-color to a three-color disruptive pattern. The new three-color design provides a more effective disruptive pattern against the threat of detection, and also provides a simpler item for industry to produce.

SYSTEMS ANALYSIS OF LIGHTENING THE SOLDIER'S LOAD: As AMC's lead activity for this effort, Natick conducted joint working group and steering committee meetings with ADEA, AMC, Office of The Surgeon General and TRADOC in preparation for the first interagency tech base demo, the purpose of which was to feature the technology trends and new equipment applicable to lightening the soldier's load. Several individual soldier equipment mockups were assembled as baselines to demonstrate the excessive loads soldiers must carry when configured to their military occupational specialties. Additionally, newly type-classified equipment was identified and its impact on load weight and volume assessed. This dynamic process of comparison and configuration will serve as a measure of progress toward mitigating the soldier's load-bearing burden over the duration of this multi-year effort. This effort offers possibilities for reducing the soldier's load by 10 percent in the near term and 50 percent in the long term.

c. Development Program (6.3B and 6.4): During FY87, our development program accomplishments included:

INTEGRATED INDIVIDUAL FIGHTING SYSTEM (IIFS): IIFS consists of several individually developed items -- INDIVIDUAL TACTICAL LOAD-BEARING VEST; FIELD PACK, LARGE, WITH INTERNAL FRAME; EXTENDED COLD WEATHER SLEEP SYSTEM; and EXTENDED COLD WEATHER CLOTHING SYSTEM -- all of which combine advantageous features of lightening the load, reduction in quantity of items, reduced bulk, designed interoperability of the separate items, and the use of high-tech materials for insulation and moisture management. During FY87, testing was successfully completed for IIFS. Minor shortcomings were corrected, check-tested, and the items approved and advanced to the ready-for-type-classification stage; the expedited fielding of selected components of the IIFS to light infantry divisions/high priority units was completed. Feedback has revealed high acceptability among test subjects and users, and the demand to obtain individual items and/or the entire system is very high.

The primary goal of the Army to reduce soldier load was met for the total System, as well as each individual item. The development cycle for the IIFS was compressed to the limit. Based on high acceptance and the demand for IIFS, Natick procured and fielded selected items well ahead of formal type classification. Innovative testing was involved in evaluating the System. The development program took maximum advantage of nondevelopmental items in fulfilling unique military requirements, while maintaining compatibility within the

IIFS and with standard items already in existence. The IIFS provided the 7th and 10th Infantry Divisions (Light) with greatly increased mobility, readiness, and mission effectiveness.

MICROCLIMATE COOLING (MCC) VEST: Development has been successfully completed and the MCC Vest has been adopted as a standard component of the M1A1 Tank. It will significantly improve combat cababilities for combat vehicle crew members who are often exposed to heat severe enough to elevate body core temperature and increase heart rate -- conditions that result in heat casualties. This is of particular concern when the crew member is wearing CB-protective clothing. The development of the MCC Vest enables the crew member to operate efficiently and significantly longer inside combat vehicles in hot climates without becoming heat casualties. MCC capabilities for air crew members are currently under development.

EXPLOSIVE ORDNANCE DISPOSAL (EOD) BODY ARMOR: Development has been successfully completed and the EOD Body Armor has been adopted as a standard system. This system will significantly improve the safety of EOD personnel. Prior to this development, no standard EOD body armor existed that provided adequate protection against fragments from exploding munitions/improvised explosive devices. Commercially available items were poorly designed, too cumbersome, heavy, expensive and, in many cases, did not provide the required level of fragmentation protection.

The Natick-developed body armor is flexible, permits unobstructed vision, unimpaired hearing, and can be worn for up to one hour without interfering with the safe conduct of EOD operations. This body armor has received favorable reception from civil police agencies, the FBI, and other Government agencies. This EOD Body Armor fulfills an urgent need for EOD personnel who previously had improper or inferior equipment.

4. PLANNED PROGRAM

With increased fiscal restraints, it is imperative that our research, technology and development program efforts be prioritized to maximize our gains for the individual soldier. To that end, therefore, our planned programs for FY88-FY89 will be focused on prioritry areas, and our major objectives include:

a. Basic Research Program (6.1)

(1) FY88 Planned Program

Characterize and optimize chemical activity of metal-organic complexes.

Develop new transparent polymers against ballistics.

Obtain fiber mechanical property data from dynamic fiber impact studies.

(2) FY89 Planned Program

Develop and transition immobilized enzymes for protection against chemical agents.

Produce ballistic protective fibers from ordered polymers and evaluate fibers under dynamic impact conditions.

Incorporate variable permeability films, developed for chemical/biological protection, into fabrics.

FOCAL POINT FOR RESEARCH PROGRAM: Dr. Abner S. Salant
Telephone: 508-651-4577

b. Technology Program (6.2)

(1) FY88 Planned Programs

Characterize breakthrough/permeation rates of agent simulants through air-impermeable materials to address the requirements for chemical protection in POL environments.

Develop prototypes of advanced laser eye protection.

Evaluate the effect of uniform coloration on relative protection against nuclear pulses to improve thermal nuclear survivability.

Conduct limited field evaluation of lower weight and bulk cold weather boots.

Design and fabricate a five-finger glove system for combat use which simultaneously provides the maximum amount of warmth, dexterity, waterproofing and durability.

Reduce the weight and bulk of the white vapor-barrier boot 25 percent without sacrificing cold weather protection by incorporating new and/or state-of-the-art materials.

Fabricate candidate composite materials and evaluate their survivability against nuclear pulse effects.

Develop prototype composite helmets for ballistic protection based on high-strength polyethylene fabrics impregnated with resins.

Develop stabilization techniques to raise the level of durability of synthetic down materials to that of conventional polyester fiber-fill.

Evaluate carbon-based fabric systems for flame-resistant, vapor-only, and reduced-threat chemical-protective applications.

Optimize fabric systems for protection against flechettes.

Explore new thermal imaging countermeasures for incorporation into field uniforms.

(2) FY89 Planned Program

Investigate methods to incorporate agent-resistant self-detoxifying materials into elastomers to improve chemical protection of clothing materials.

Design a man-portable cooling unit to reduce heat stress of the individual soldier in Mission-Oriented Protection Posture (MOPP) gear.

Develop lighter weight, less bulky insulation for arctic uniforms.

Evaluate candidate materials for use in a full-face ballistic-protective system.

Develop laser/eye devices for tunable laser protection.

Evaluate permeable hydrophobic chemical-protective membranes for clothing applications.

Establish numerical models to predict the ballistic performance of individual armor materials.

Explore advanced composites for multiple-threat ballistic protection.

Optimize fabric construction for new fibers to provide lighter weight ballistic protection.

FOCAL POINT FOR TECHNOLOGY PROGRAM: Mr. Maurice Denommee
Telephone: 508-651-4447

c. Development Program

(1) FY88 Planned Program

(a) Advanced Development:

Continue the development of the most effective available multiline laser/ballistic eye protection for the individual soldier.

* Complete development of an INDIVIDUAL CAMOUFLAGE COVER (ICC).

Continue the development of HYBRID (air/liquid) MICROCLIMATE COOLING EQUIPMENT (MCE).

Continue the development of a MULTIPURPOSE OVERBOOT (MULO).

Continue development of an interim and final SELF-CONTAINED TOXIC ENVIRONMENT-PROTECTIVE OUTFIT (STEPO).

Continue the development of heated gloves for aircrewmen.

(b) Engineering Development:

* Complete development of an AIRCREW BATTLE DRESS UNIFORM (combined flight/ground operational uniform).

* Complete development of an AIRCREW UNIFORM INTEGRATED BATTLEFIELD (AUIB) [chemical-protective and flame-resistant, aircrew life support equipment and MCC compatible].

Continue the development of nonprescription BALLISTIC EYE PROTECTION (BEP).

Complete the development of a CANTEEN FOR EXTREME CLIMATES

Complete the development of a SUIT, CONTAMINATION AVOIDANCE AND LIQUID PROTECTIVE (SCALP).

Complete development of PARACHUTIST'S ROUGH TERRAIN SYSTEM (PRTS) for SOF.

Complete development of SNOW AND ICE TRAVERSING EQUIPMENT (SITE) for SOF.

Complete development of SURVIVAL ARMOR RECOVERY VEST, INSERT AND PACKETS (SARVIP).

Continue development of GRENADE VEST.

(2) FY89 Planned Program

(a) Advanced Development

Complete advanced development of heated gloves for aircrewmen.

Continue development of laser/ballistic eye protection.

Complete development of hybrid microclimate cooling equipment.

Complete advanced development of MULTIPURPOSE OVERBOOT (MULO).

Complete development of interim SELF-CONTAINED TOXIC ENVIRONMENT-PROTECTIVE OUTFIT (STEPO); continue development of final outfit.

Initiate multiple-threat ballistic armor, individual soldier microclimate cooling equipment, and integrated combat vehicle crewman clothing system.

(b) Engineering Development

Initiate development of intermediate cold/wet boot system.

Continue development of nonprescription BALLISTIC EYE PROTECTION.

Complete development of SUIT, CONTAMINATION AVOIDANCE AND LIQUID-PROTECTIVE.

Complete development of the GRENADE VEST program.

Initiate AIRCREW COLD WEATHER, SOLDIER GROUND INSULATOR, COMBAT SOLDIER SLEEPING BAG, LIGHTWEIGHT CB GARMENT, LIGHTWEIGHT BATTLE DRESS UNIFORM, MASK DRINKING SYSTEM, and COMMUNICATIONS/AURAL-PROTECTIVE SYSTEM.

* FOCAL POINTS FOR DEVELOPMENT PROGRAM:

1. Mr. Donald A. Cerow
   Telephone: 508-651-4224
   (For all items marked *)

2. Mr. Charles R. Williams
   Telephone: 508-651-4120
   (For all unmarked items)

5. MAJOR TECHNOLOGICAL BARRIERS

The major technological barriers that must be overcome to achieve near- to midterm CIE Program objectives include:

a. IMPROVED CHEMICAL-PROTECTIVE MATERIALS: CP materials are needed to provide increased protection, including biological agent protection, over the current system at reduced weight and heat stress and with increased durability and shelf-life.

Technical POCs: Dr. Eugene Wilusz
Telephone: 508-651-5486

Mr. Gary Olejniczak
Telephone: 508-651-4046

b. LIGHTWEIGHT BALLISTIC MATERIALS: Lightweight ballistic materials are needed to provide increased protection against fragments and flechettes. Also needed are light transparent materials for eyewear with

improvements in ballistic penetration, scratch resistance, optical clarity and the ability to be integrated into laser eye protection concepts.

Technical POCs: Dr. Frank Bissett
Telephone: 508-651-4585
Mr. Gary Olejniczak
Telephone: 508-651-4046

c. ADVANCED COUNTERSURVEILLANCE MEASURES: Improved camouflage materials are needed to provide protection against evolving radar, thermal and laser threats, and to provide passive camouflage to soldiers operating in urban and arctic environments.

Technical POC: Ms. Therese R. Commerford
Telephone: 508-651-5469

d. PROTECTION AGAINST DIRECTED ENERGY WEAPONS (DEW): Improved combat clothing materials are needed to provide thermal protection against high-energy lasers. Also, current shortcomings in eye protection against fixed-frequency lasers, i.e., low visual transmittance, poor durability and high cost, need to be overcome.

Technical POC: Dr. Frank Bissett
Telephone: 508-651-4588

e. MAN-PORTABLE MICROCLIMATE COOLING SYSTEM: Advanced heat exchange technology and compact, long-lasting power sources are needed.

Technical POCs: Mr. Michael Kupcinskas
Telephone: 508-651-5443
Mr. Il Young Kim
Telephone: 508-651-5441

The major technological barriers that must be overcome to achieve mid- to long-term CIE Program objectives are indicated in the APPENDIX.

6. PROGRAM RELATIONSHIPS AND INTERACTIONS

a. Natick has significant interaction with most of the other seven AMC RD&E centers with CIE areas.

(1) Support is needed <u>from</u>:

USA Belvoir RD&E Center on microclimate conditioning and camouflage development;

USA Communications-Electronics RD&E Center for night vision/laser eye protection communications and electrical/battery areas;

USA Aviation RD&E Center for aviation life-support equipment;

USA Tank-Automotive RD&E Center for microclimate conditioning interface information;

USA Chemical RD&E Center for CB test methodologies, CB agent testing services and initial data assessments, the development

of agent surrogates for chemical agents, methodology to assess the vulnerability/survivability of items on the CB battlefield, and expert advice on CB protection/decontamination matters.

Support needs from USA Armament and Missile RD&E Center are minimal.

(2) Support is given by Natick to:

USA Belvoir RD&E on microclimate cooling;

USA Armament RD&E Center on holsters and ammunition pouches;

USA Missile RD&E Center on special ballistic protective items;

USA Aviation RD&E Center on protective clothing and equipment;

USA Chemical RD&E Center on chemical-protective clothing to interface with mask systems. Expertise is provided in the areas of handwear, footwear, complete clothing systems, anthropometry, laundering procedures, and laundering to include units used for decontamination, equipage, microorganism/material interaction, analytical chemistry, and systems analyses associated with the foregoing areas. Cooperative studies are conducted to gain fundamental understanding of CB-protective concepts, materials, and procedures.

b. Natick also has extensive interaction with most of the LABCOM Corporate Laboratories in the CIE area.

(1) Support is needed from:

USA Ballistic Research Laboratory on ballistic models, ballistic testing, and casualty reduction analysis;

USA Human Engineering Laboratory on human performance testing, test bed for Lightening the Soldier's Load and Human Factors;

USA Harry Diamond Laboratories on nuclear effects testing and nuclear evaluation data;

USA Materials Technology Laboratory on material technology and modeling of materials, ceramics, elastomers, metals, composites and transparent ballistic materials, ballistic firings, chemical permeation, and laser materials.

(2) Support is given by Natick to:

USA Ballistics Research Laboratory on ballistic modeling applicable to the individual soldier and information on microwave protection;

USA Human Engineering Laboratory on Lightening the Soldier's Load tech demo participation, anthropometry support, clothing, and human engineering factors;

USA Materials Technology Laboratory on the application of materials modeling for the individual soldier, fiber and textile materials technology, elastomer compounding service, information on spectrometric tests, wet chemistry, materials/lasers, microbial protection for materials, and weathering.

c. Natick also interacts with the Office of The Surgeon General on heat stress information for chemical-protective clothing, human performance modeling, and soldier's load information.

d. Natick interacts with other Services, other government agencies, and foreign governments to meet technology needs. Examples of these types of interactions are:

Air Force: High performance polymer technology, life support technology for aviator and CD models;

Other DoD Agencies: Clothing manufacturing technology;

Foreign-tech data exchanges, International Materiel Evaluations (IME), and system alternatives.

e. Natick offers the following types of technical support to:

Navy, Air Force and Marines: Multi-Service chemical defense and dress clothing technology (Natick is the lead Service), reimbursable order pattern grading;

Marines: RDT&E reimbursable orders;

Other DoD Agencies: Engineering support to DPSC for clothing and individual equipment;

Other Government Agencies: Ballistic eye protection work, Postal Service work;

Foreign Agencies: NATO, ABCA, and DEA information/item exchanges; also procurement of clothing for Saudi Arabia.

f. Our interactions with Industry and market surveillance are ongoing processes which are enhanced by the active participation of our official Natick representatives to 115 nongovernmental technical committees and the active membership of Natick employees in national scientific and technical associations/societies such as:

ACS, AIC, AIChE, ANS, APA, APS, ASME, IFT, ORSA, SAME, AATCC, AATT, AIAA, APHA, ASM, RSC, Sigma Xi, and STC.

In addition, we formally interact with Industry during several key events in the R&D life cycle -- at the time of formulation of the requirement document, when conducting a market analysis, during the preparation of specifications and standards, and the preparation of standardization program analyses/plans.

We are also active participants in the Independent R&D Program, the Army Information for Industry Program (including the Army Potential Contractor Program, the use of Broad Agency Announcements and Advanced Planning Briefings for Industry), the Unsolicited Proposals Program and the Small Business Innovative Research Program.

g. We use the technical expertise available in the academic community. We are strong supporters of the Polymer Science activities under the auspices of the Massachusetts Centers of Excellence. Natick is a member of the Northeastern University Cooperative Research Center for Electromagnetic Research (for laser protection programs) and is in the process of evaluating proposals for the establishment of a Textile Technology Center within academia.

h. We also interface with the various TRADOC schools (e.g., the Infantry School) on soldiers' needs and requirements early on, and maintain close coordination throughout the development process. Once we enter the advanced development and engineering development phases, our funding and program guidance is furnished by the Project Manager for Clothing and Individual Equipment (PM-CIE). We have also established an interface with Forces Command units to periodically obtain user feedback for our fielded items.

This document reports research undertaken at the US Army Natick Research, Development and Engineering Center and has been assigned No. NATICK/TR-88/079 in the series of reports approved for publication.

A P P E N D I X

TECHNICAL OBJECTIVE DOCUMENT
FOR
COMBAT CLOTHING, UNIFORMS
AND
INTEGRATED PROTECTIVE SYSTEMS

MAY 1988

NG/NS TITLE: *INTEGRATED PROTECTIVE CLOTHING SYSTEM (IPCS)*

DESCRIPTION:

IPCS will provide the soldier with improved protection against individual threats by integrating the technology advances in the tech demo areas into a single uniform ensemble, instead of a number of separate items. This combat fighting system will provide advanced individual protection and enhanced soldier performance and survivability. The system consists of a uniform, integrated helmet (using the RESPO 21), handwear, footwear, body armor, and man-portable microclimate conditioning equipment.

MAJOR COMPONENTS:

The major components of the IPCS are:

- Individual Soldier Microclimate Conditioning Equipment (MCE)
- Integrated Protective Clothing: Semipermeable, chemical/biological/ballistic/flame/directed energy weapons-protective, reduced signature
- Advanced Protective Helmet: Chemical/biological/ballistic/laser-protective, integral respiratory capability, communications display
- Body Armor: Articulating, lightweight, chemical/biological-resistant, multiple threat protective
- Protective Glove - chemical/biological- and ballistic-protective, flame and POL-resistant
- Protective Footwear - chemical/biological- and ballistic-protective, flame and POL-resistant, lightweight

TECH BARRIERS:

- Improved Chemical/Biological Protective Materials
- Lightweight Ballistic Materials
- Advanced Countersurveillance Measures
- Advanced Technology for Protective and Tactical Helmet Systems
- Man-Portable Microclimate Conditioning
- Laser Protection for the Eyes
- Protective Measures Against Directed Energy Weapons.

STATUS: Funding for technology demonstrations (6.3A) is scheduled for FY90.

NOTE: Additional information is furnished for the major components of IPCS on the following data sheets.

Technical POCs for IPCS: Mr. Maurice Denommee
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Mr. Charles Williams
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TITLE: INDIVIDUAL SOLDIER MICROCLIMATE CONDITIONING EQUIPMENT (MCE)

RELATIONSHIP TO NG/NS

The MCE System will be used in conjunction with the Integrated Protective Clothing System to regulate body heat and thereby increase the operating time and effectiveness of the soldier in environmental extremes.

DESCRIPTION

Current plan is to develop and demonstrate new technological systems capable of regulation of body heat and moisture at various work loads and under various environmental conditions, using active (microclimate cooling or heating) or passive systems for control of the microenvironment within a combat uniform system. This prototype will demonstrate integration of climate-control technologies with new multihazard-protective clothing and equipment systems to enhance soldier operability/survivability and combat effectiveness.

OBJECTIVE/APPROACH

Objective is for individual protective ensembles to have a powered engineering system that provides positive control of body heat and moisture over broad ranges of metabolic rates and environmental conditions.

Tech barriers that need to be overcome are:

- System Design: Advanced heat exchange technology, compact, long-lasting power sources.

- Optimize Man/Machine Interface: Lightweight components and equipment integrated with uniform system for optimization of maneuverability and mission effectiveness of the soldier. Placement of equipment should be consistent with the center of gravity for ease of carrying its weight.

- Signature Reduction: Advanced countersurveillance materials, including individual soldier radar protection, camouflaged materials, countermeasures to minimize detection from evolving radar, thermal and noise signature.

- Manufacturing Process: MCE unit cost effective producibility.

REMARKS

In direct support of:

o The Individual Soldier MCE System

Draft Statement of Need -- Clothing and Individual Equipment (SN-CIE) for Individual Soldier Microclimate Conditioning Equipment. Joint effort with Belvoir RD&E Center.

Technical POCs for MCE: Mr. Michael Kupcinskas
Telephone: 508-651-5443

Mr. Il Young Kim
Telephone: 508-651-5441

TITLE: INTEGRATED PROTECTIVE CLOTHING - SEMIPERMEABLE, CHEMICAL/BIOLOGICAL-, BALLISTIC-, FLAME-, DIRECTED ENERGY WEAPONS-PROTECTIVE, REDUCED SIGNATURE

RELATIONSHIP TO NG/NS

Integrated Protective Clothing will be used in conjunction with the helmet system, glove and footwear systems, and the Microclimate Conditioning unit. When fully integrated, system will provide advanced individual protection and enhanced soldier performance and survivability.

DESCRIPTION

Develop and fabricate prototype protective uniform systems integrating protection from flame, ballistic, nuclear/biological/chemical(NBC), directed energy weapons (DEW), and environmental threats. Field demonstrations would provide data to support the feasibility of the concepts, which could be tailored to provide the appropriate protection levels and design configurations for the different Military Operational Specialties, i.e., ground soldier, combat vehicle crewman, etc. This protection includes advanced countersurveillance methods of reducing the signature of the soldier from visual, infrared, radar and thermal detection.

OBJECTIVE/APPROACH

The objective is to provide improved soldier protection against individual threats while placing major emphasis on integrating the technology in these areas into a single uniform ensemble.

Tech barriers are:

- Barrier Materials: Lightweight, low heat stress chemical/biological (CB) materials, fire-retardant (FR), petroleum-, oil-, and lubricant- (POL-) resistant shell fabrics.

- Adsorbent Fibers and Fabrics, Protective Clothing: Integrated chemical protective/ballistic protective materials/material systems.

- Catalytic Systems: Chemical agent detoxification materials.

- Chemical Monitors: Integral CB wear life indicators.

- Laser, Microwave: Integration of these with ballistic protection.

- Signature Reduction: Advanced countersurveillance materials, to include individual soldier radar, thermal, and visual protection. Chameleon camouflage materials, which assume spectral characteristics of background environment.

- System Design: Waste management designs, integration of protective materials and functional capabilities, lightweight.

- Overpressure/Blast Effects: Blast energy, overpressure, thermal pulse-absorbing materials.

- Launderability/Cleanability/Decontaminability: Maximum service, wear-life, hygiene.

- Human Factors Considerations: Minimal degradation of normal functions for maximum functionality and operational effectiveness.

REMARKS

In direct support of:

o Combat Vehicle Crewman Protective Ensemble (CVCPE)

o Maneuver Arms Tactical Protective System (MANTAPS)

o Joint effort with U.S. Army Materials Technology Laboratory (MTL)

Technical POCs: Mr. Maurice Denommee
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Ms. Carol Fitzgerald
Telephone: 508-651-5436

TITLE: ADVANCED PROTECTIVE HELMET - CHEMICAL/BIOLOGICAL-, BALLISTIC-, LASER-PROTECTIVE, INTEGRAL RESPIRATORY CAPABILITY, COMMUNICATIONS DISPLAY

RELATIONSHIP TO NG/NS

Advanced Protective Helmet will be used with the Individual Protective Clothing System, providing a multihazard-protective capability.

DESCRIPTION

Fabricate a modified prototype of and demonstrate the technical/operational cababilities of an advanced integrated helmet, including ballistic/impact/spall protection, aural protection/communication capabilities, protection from directed energy weapons (DEW), chemical/biological (CB) protection, and ventilated facepiece. This multihazard-protective helmet will enhance soldier survivability and combat effectiveness of the individual ground soldier, combat vehicle crewman, and artilleryman. The system will be lightweight, impose minimum heat stress, provide CB protection without the need for a conventional mask, and contain a video display capability for projection of tactical information and the capability of linking to a weapon-sighting/fire control system/night vision system.

OBJECTIVE/APPROACH

The objective is for the individual soldier to be equipped with a fully integrated multihazard/multicapability-protective helmet.

Tech barriers are:

- Integration of laser/ballistic protective materials.
- Lightweight.
- Integration of respiratory protection.
- Material Properties of Unconventional Armors: Lightweight ballistic-protective materials.
- Overpressure/Blast Effects: Materials that absorb or dissipate energy from blast/thermal pulse.
- Laser Protection: Integration with ballistic-protective materials.
- Manufacturing Process: Ability to produce integrated helmet.
- System Design: Lightweight microelectronic components for communications/tactical information displays/sensors. Optimize man/machine interface and encompass first to 99th percentiles.

- Compatibility or minimal degradation of normal functions (sight, speech, hearing). Accommodate heat and moisture (metabolic variations).

- Signature Reduction: Advanced countersurveillance materials, to include individual soldier radar, thermal, and visual protection.

- Target/Image Processing: Helmet display linked with weapons sighting system.

- Subsistence: Capability for the helmet-clad soldier to maintain physiological balance while intaking subsistence items through the helmet system

REMARKS

In direct support of:

o Integrated (CB-protective) Combat Vehicle Crewman (CVC) Helmet System

o Ballistic/Laser System for Head/Face

o Headset, Communication Noise Protection, Artilleryman.

Could be utilized in conjunction with the Joint Service Small Arms Program Development.

Joint effort with U. S. Army Chemical Research, Development and Engineering Center (CRDEC), U. S. Army Communications-Electronics Command (CECOM), and U. S. Army Materials Technology Laboratory (MTL).

Technical POC: Mr. Stan Waclawik
Telephone: 508-651-5447

TITLE: BODY ARMOR - ARTICULATING, LIGHTWEIGHT, CHEMICAL/BIOLOGICAL-RESISTANT, MULTITHREAT PROTECTION

RELATIONSHIP TO NG/NS

Body Armor with an articulating configuration will be used in conjunction with the Integrated Protective Clothing System.

DESCRIPTION

The principal objective of this particular effort is to develop a flexible material system that provides protection against flechettes while maintaining fragment protection. If flexible materials cannot be developed, metallic materials will be segmented, hinged and overlapped in configurations that reduce noise of the components and physiological stress to the wearer. It will provide the maximum amount of unrestricted movement while still providing the required protection.

OBJECTIVE/APPROACH

The objective is to develop state-of-the-art body armor that has the essential characteristics required by the infantryman.

Tech barriers are:

- Ballistic Protection: Vest must encompass all of the fragmentation protection capabilities of the PASGT Vest, along with the ability to defeat flechettes.
- Directed Energy Weapons and Overpressure/Blast Protection: Integration of these protection capabilities.
- Body Armor: Compatibility of body armor with all items of individual clothing and equipment.
- Human Factors Issues: Address human factors issues properly in order to cause no undue hindrance either to the senses or normal movement of the body.
- Articulating Configuration: In order to provide maneuverability without decreasing protection.
- Reduction in Weight: Maintain protection and decrease weight or maintain weight and increase protection.

REMARKS

In direct support of:

- o Advanced LTWT Ground Troop Vest
- o Multiple Threat Body Armor
- o Advanced Concepts for Blast/Pulse Protection

Draft Statement of Need — Clothing and Individual Equipment (SN-CIE) for Multiple Threat Body Armor (MTBA).

Technical POC: Mr. Stan Waclawik
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TITLE: PROTECTIVE GLOVE CHEMICAL/BIOLOGICAL/BALLISTIC-PROTECTIVE, FLAME- AND POL-RESISTANT, LIGHTWEIGHT

RELATIONSHIP TO NS/GS

Protective Glove will be used in conjunction with the Integrated Protective Clothing System, providing the hands with protection from multiple hazards.

DESCRIPTION

Fabricate modified prototypes using high-performance fibers and lightweight materials. Demonstrate concepts for integration of various types of protection to include flame-resistance (FR), chemical/biological- (CB) and petroleum-, oil-, and lubricant- (POL) resistance, decontaminability, and environmental protection into a single glove system, while maintaining maximum levels of dexterity and maneuverability. This system would be compatible with hand weapons and equipment items.

OBJECTIVE/APPROACH

The objective is for a glove, fully dexterous yet protective and comfortable, which can be directly and securely interfaced with the integrated uniform system.

Tech barriers are:

- Barrier Materials: Protection from CB agents, FR- and POL-resistant. Lightweight, low heat-stress materials, tactile, strong.
- Manufacturing Process: Innovative construction of glove system; producibility.
- Human Factors Considerations: Maximize tactility/dexterity with levels of protection in glove system.
- Laser and microwave protection: Integration of these capabilities with other protective materials.
- Some degree of fragmentation protection.
- Signature Reduction: Advanced countersurveillance materials, to include individual soldier radar, thermal, and visual protection.

REMARKS

In direct support of:

o Advanced Integrated Handwear

o Chemical Warfare (CW) Ballistic-Protective and POL-Resistant Tactile Glove

Draft Statement of Need — Clothing and Individual Equipment (SN-CIE) for combat glove.

Technical POC: Ms. Linda Wells
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TITLE: PROTECTIVE FOOTWEAR - CHEMICAL/BIOLOGICAL-, BALLISTIC-PROTECTIVE, POL-RESISTANT AND LIGHTWEIGHT

RELATIONSHIP TO NG/NS

The Protective Footwear technology demonstrator will be used in conjunction with the Integrated Protective Clothing System. It will, however, also have the ability to provide foot protection when used independent of the fighting system.

DESCRIPTION

The plan is to fabricate footwear that demonstrates high-tech concepts for integrated protection in a single boot system. This includes protection from ballistic threats, blasts, countermines, falling objects, and chemical warfare (CW) agent penetration.

OBJECTIVE/APPROACH

Goal is to provide a footwear system that can be used in conjunction with the Integrated Protective Clothing System.

Tech barriers are:

- Protection of lower limbs from exploding landmines and countermines.
- Material Properties of Unconventional Armors: Lightweight ballistic-protective materials.
- Ballistic Materials for Infantry and Crew Protection: Integrated ballistic-protective materials which increase protection at reduced weights.
- Manufacturing Process: Boot producibility.
- Signature Reduction: Advanced countersurveillance materials. Camouflage materials.
- Barrier Materials: Lightweight, low heat stress CB materials. Elastomeric materials for all environments. POL-resistant.
- System Design: Integration of protective materials.
- Catalytic Systems: Chemical agent decontaminability.

REMARKS:

In direct support of:

- o Ballistic-Protective Combat Footwear
- o Integrated Lightweight Combat Boot

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